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ABSTRACT

Minorities are a growing proportion of Americans, and the nation can no longer afford to leave any fraction of its population uneducated and unable to participate in a wide variety of professional fields and to function appropriately as taxpaying citizens. This paper examines present minority participation in engineering and science through the whole educational pipeline. Statistical data provide trends for: (1) undergraduates; (2) graduates; (3) master's degrees; (4) doctoral degrees; and (5) faculty. Lists 12 references. (YP)

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AMERICAN MINORITIES

IN SCIENCE AND ENGINEERING

by

Betty M. Vetter

Occasional Paper 89-3

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AMERICAN MINORITIES IN SCIENCE AND ENGINEERING

by

Betty M. Vetter

Adapted from a

Presentation on May 3, 1989 to a

Conference on Minority Recruiting
at the

Massachusetts Institute of Technology
Boston, Massachusetts

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Figures 3, 4, 6 and 29 are from "Personnel in Natural Science and Engineering," an unpublished working draft dated June 1988, prepared by the National Science Foundation.

All remaining figures were prepared by Richard C. Vetter from tables for the eighth edition of **Professional Women and Minorities: A Manpower Data Resource Service,** to be published in fall 1989 by the Commission on Professionals in Science and Technology.

AMERICAN MINORITIES IN SCIENCE AND ENGINEERING

American minority scientists and engineers make up only a fraction of their appropriate share of those occupations, relative to their representation in the U.S. population. The reasons why this is so include prejudicial treatment, lack of role models, inferior educational opportunities, and perhaps a number of other things. But the reasons are not what matters most now. Instead, what is important is that minorities are a growing proportion of Americans, and the nation can no longer afford to leave **any** fraction of its population uneducated and unable to participate in a wide variety of fields, to be utilized in all kinds of positions, and to function appropriately as taxpaying citizens. The nation needs minorities in science and engineering for the same reasons that they are needed in law and medicine, architecture and art - so that the nations professionals mirror her population, and the talents of her people are utilized.

But in science and engineering particularly, they are needed because the nation faces a potential shortfall of considerable magnitude in some of these areas, and white males cannot continue to fill all of the national needs by themselves. In engineering and the physical sciences, women of any race are a minority group, so that consideration of American minorities in some fields must include majority as well as minority women.

To understand where we need to go, we must look first at present minority participation through the whole educational pipeline, before comparing probable output in science and engineering with some of the forecasts of demand. To set the stage, figure 1 shows minority proportions in various populations based on age and educational attainment.

Black and Hispanic students have slowly increased their share of high school graduates in recent years, although the rate of graduation for both of these groups and for Native Americans is below that of the white, non-minority population. However, at each succeedingly higher level of educational attainment, these three groups become a smaller and smaller percentage of the total. At the baccalaureate level, their share of earned degrees in all fields combined considerably exceeds their share of science and engineering degrees, indicating that an even smaller proportion of the black, Hispanic and Indian students who graduate from college than of either white, non-Hispanic or Asian American graduates major in science or engineering fields.

The Asian students differ in several ways from the other minority students, but particularly in their educational attainment and their apparent propensity to choose math-based fields. Their representation is higher among science and engineering bachelor's graduates than among all individuals earning baccalaureate degrees. Among all doctorate recipients, the Asian American group is neither under- or over-represented, relative to their proportion in the population, but the other minority groups are far less likely than white Americans to earn a PhD, whether in science or in any field. We will see later that most Asians who earn doctorates in American Universities were not born in the United States.

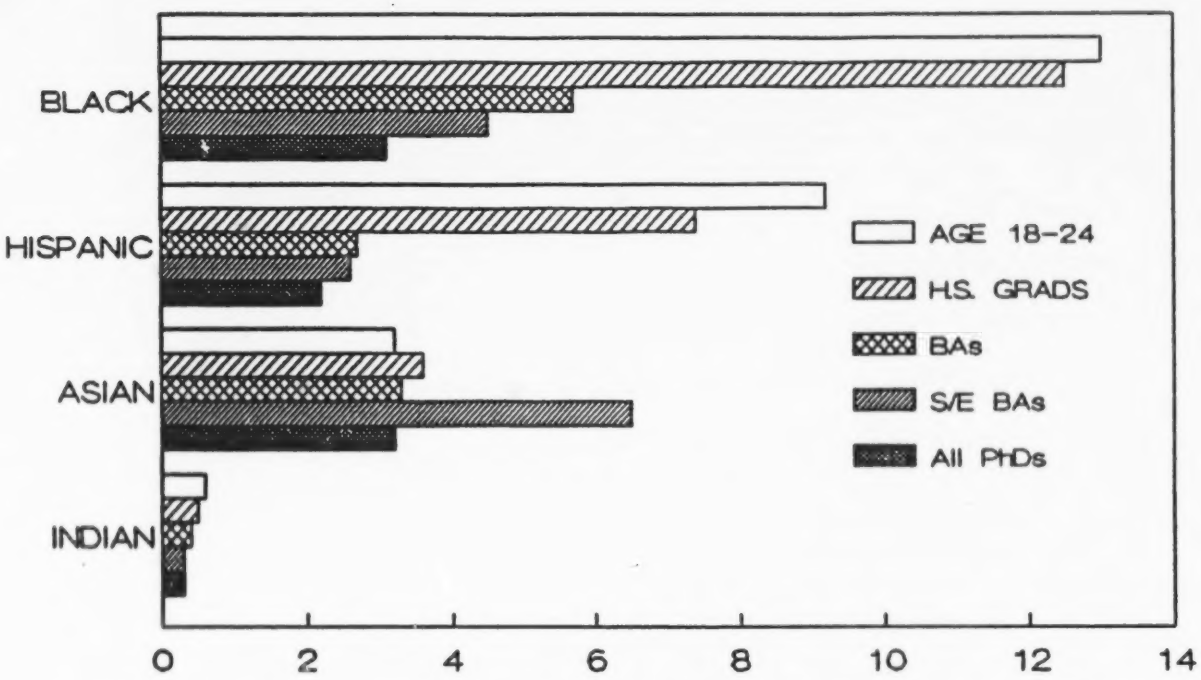


Figure 1. Percent Minorities in Various U.S. Population Groups by Education Level. Data Sources: U.S. Bureau of the Census, National Center for Education Statistics.

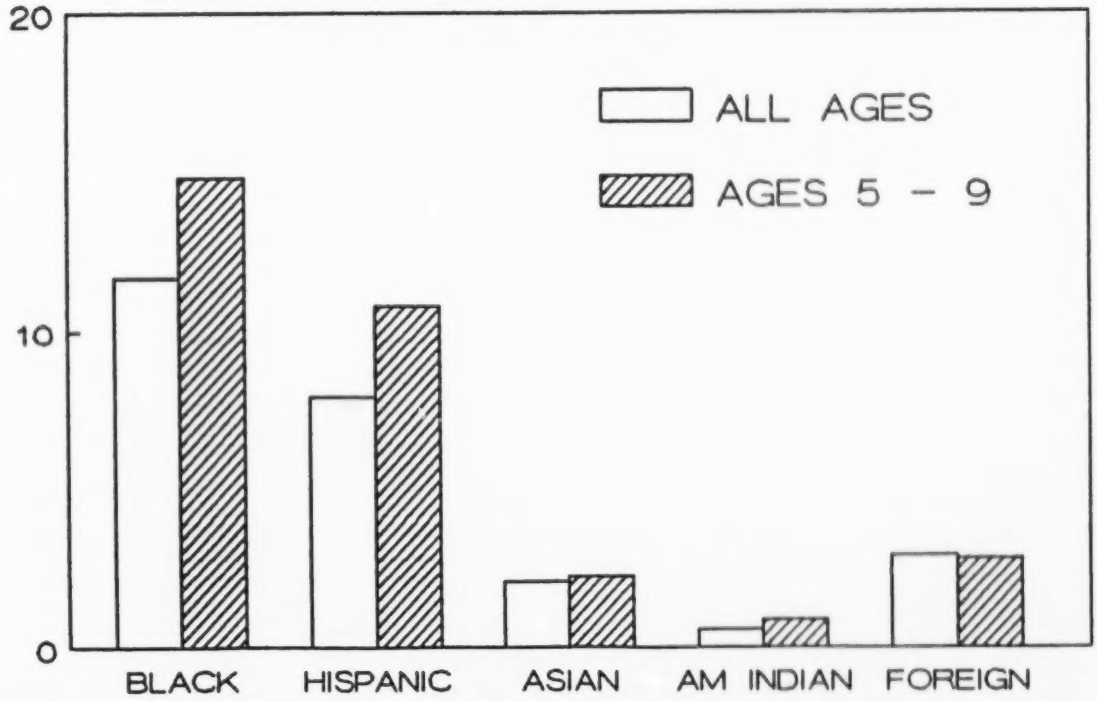


Figure 2. Percent Minorities in Total U.S. Population and Ages 5-9. Data Source: Bureau of the Census

Population Changes

The minority populations in the United States also are growing considerably faster than the white, non-Hispanic population. One way to see this is to note the larger representation of minorities among elementary school age children (fig. 2). Compared with non-Hispanic whites, Mexican American and black American populations have somewhat higher birth rates, a considerably lower median age, and more rapid immigration, particularly among Hispanics. These factors are combining to increase representation of these minority populations in the United States at a fairly rapid pace.

At least in the past, American schools have not managed to maintain interest in science and mathematics among black, Hispanic and American Indian students even to the degree that it was maintained among white and Asian students. Thus, at every higher stage of education, the proportion of minority students still expressing some interest in continued study of science and mathematics dropped off faster than for majority students (fig. 3). Since it is also true that boys have been much more likely than girls to continue interest in science (fig. 4), this has resulted in acceptance of an adult population of scientists and engineers who are largely white and male - a situation that cannot continue in the future for a number of reasons.

The first of these is the drop in births that occurred beginning in the early 1960s (fig. 5). The total drop is about 26 percent, and occurs over several years. Just as the baby boom generation of children born between the end of World War II and 1965 produced a bulge that moved from elementary school to high school to college etc., the birth dearth also moves across age groups, affecting each age at a different time (fig. 6). For example, in 1988, the 14 year old population was at its lowest point so that junior high schools had empty classrooms while elementary schools were filling up again, and high schools were still dropping, except for the small upward blip in 18 year olds that occurred that year.

Despite the drop in college age Americans, our colleges continued to produce larger numbers of bachelor's graduates each year, because an increasing number of students of non-traditional age were enrolling and graduating, although the number of 22 year olds peaked in 1982. The effect of the dropping age group is seen more readily in fields such as engineering, which is somewhat less likely to attract older or returning students than is true for the humanities and the social sciences. In engineering, B.S. degrees have been dropping since 1985, although a continued increase in women held them up for two years beyond the age group peak. The age 22 population, after a small increase to 1990, will start down again, dropping 15 percent in three years, and bottoming out about 1996. Meantime, the age 30 population - typical age for a Ph.D. - peaks in 1989 and will hit bottom about 2004 when demand for replacements for the aging American doctorate population in science and engineering will have increased substantially.

Engineering Undergraduates.

Engineering shows some of the effect of the changes that have been occurring. Engineering is the only field in which we have data to measure students even at the freshman year, and can compare freshman enrollment with degree data four years later.

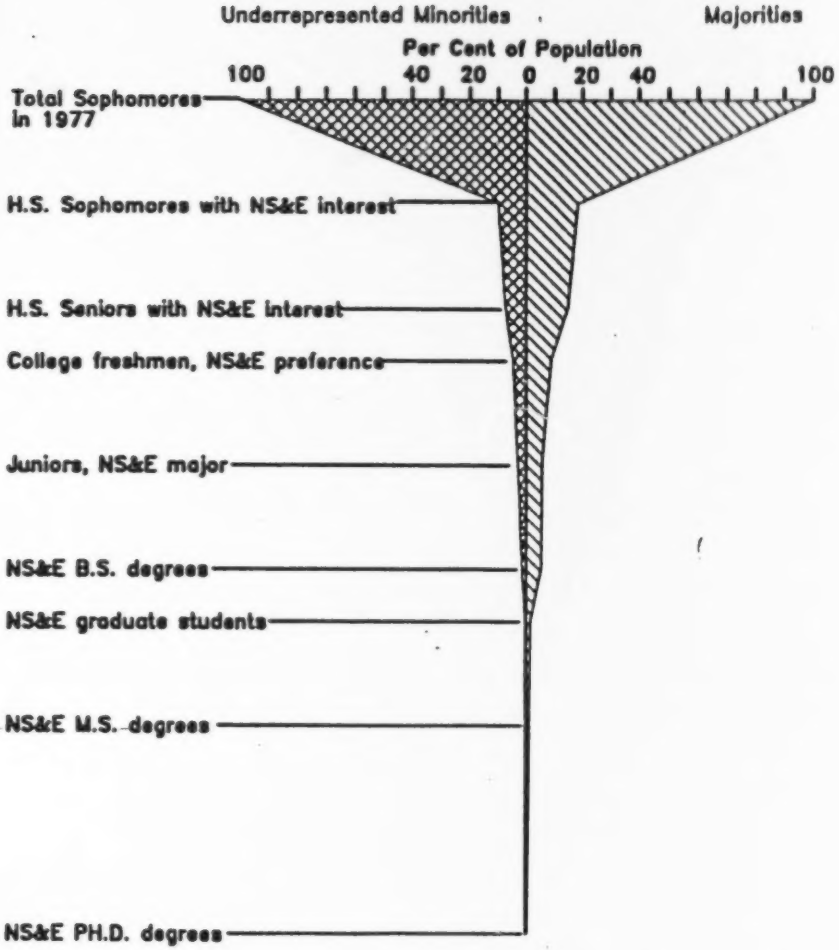


Figure 3. Persistence of Interest in natural Science and Engineering, by Ethnicity
Source: National Science Foundation

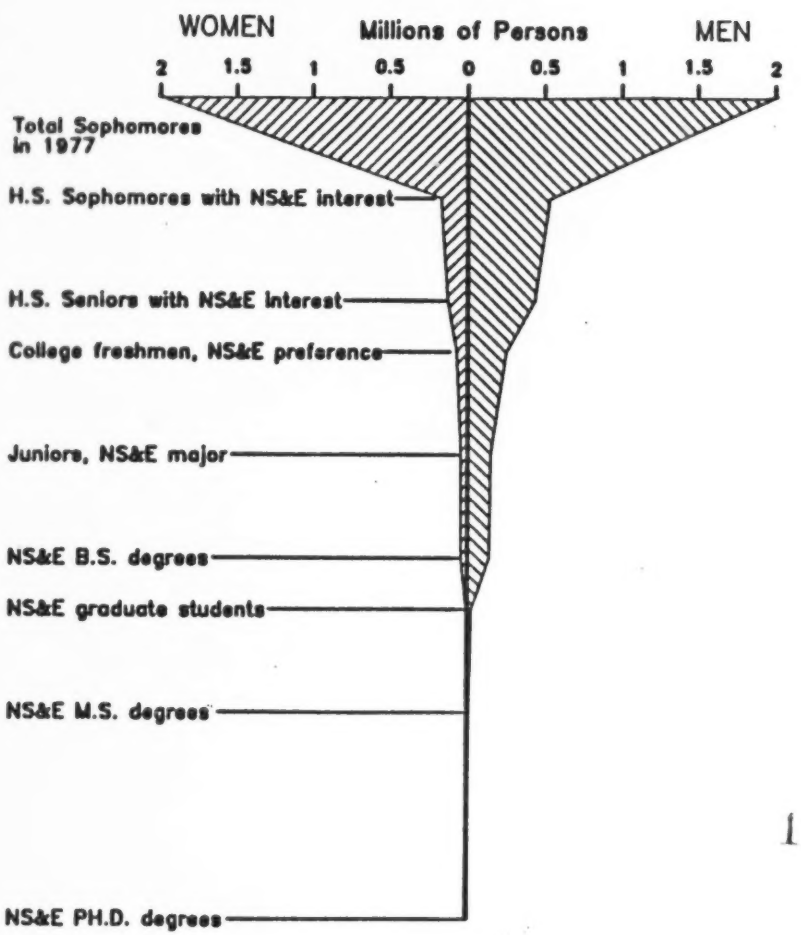


Figure 4. Persistence of Interest in Natural Science and Engineering by Sex
Source: National Science Foundation

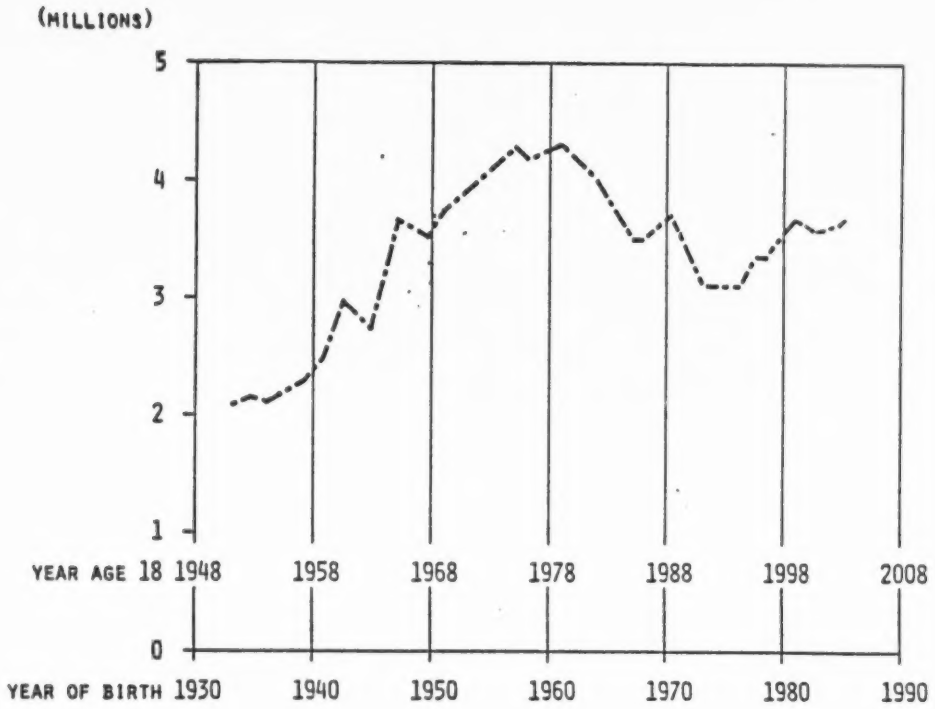


Figure 5. Births in the United States, and Year Age 18. Data Source: National Center for Health Statistics.

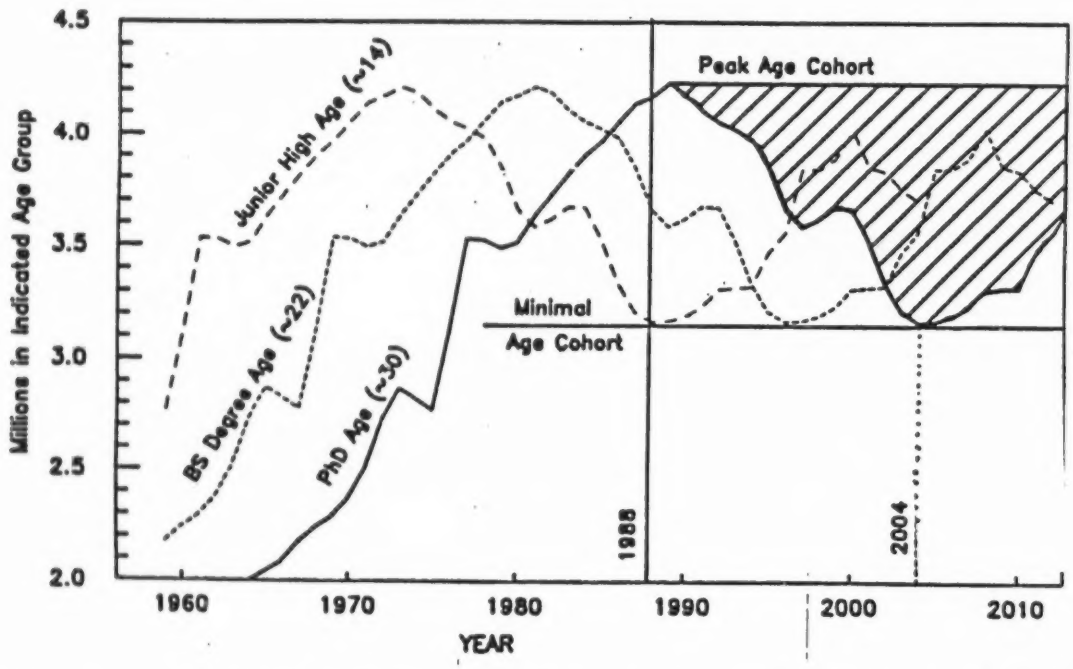


Figure 6. Shifting Population Shortfall, Junior High Through PhD Age. Source: NCHS and National Science Foundation

In addition, engineering is a field that has been strongly dominated by white males, so that any significant effort to increase the number of graduates will require enlisting minorities and women.

The number of freshmen enrolled in engineering peaked in 1982, then fell steadily through 1987 before increasing slightly in fall 1988 following the curve in 18 year olds. The number of women in the freshman class increased steadily through the 1970s, peaking at 17 percent of the class in 1983, but has remained stable at about 15 percent of the total since 1983 (fig. 7).

A number of corporations, educational groups and organizations recognized early in the seventies that the only way to bring minorities into the engineering workforce was to find and assist young minority men and women who were both interested and capable of achieving an engineering education. Several groups were organized early in that decade to recruit and assist underserved minority youth to enter this field. These included such groups as the National Action Council for Minorities in Engineering, Inc. (NACME), the National Association of Minority Engineering Program Administrators (NAMEPA) and the National Consortium for Graduate Degrees for Minorities in Engineering, Inc. (GEM).

Their efforts were rewarded during the 1970s with sharp increases in the number of black, Hispanic, and Native American students enrolling as engineering freshmen (fig. 8). The steady increase in the number of Asian students in the freshman engineering class was independent of these efforts, which were concentrated on the so-called underserved minority groups.

By 1982, however, the number of black, Hispanic and American Indian students stopped increasing, and in the case of blacks, actually fell for most of the next five years. Not until fall 1987 and 1988 has there been a substantial increase in the number of minority students enrolled at this level.

Although the number of minority freshman in engineering remained relatively small, and their proportion of the freshman class was only about half of their representation within the American college age group, the numbers of minority engineers would have increased steadily if these minority freshmen had completed their degrees at the same rate as other students and entered the labor force. Unfortunately, the minority attrition rate was very high, and the majority of black, Hispanic and Indian freshmen did not appear in the baccalaureate graduating class four years later.

There are no national data on student attrition in engineering or in other fields, for minorities or anyone else. However, while it is obvious that all of the students in the graduating class were not members of the freshman class four years earlier, the long data bases on enrollments and on degrees that are maintained by the Engineering Manpower Commission allow a legitimate comparison between the freshman classes and the graduating classes four and a half years later. What this comparison shows for the minority students is that each graduating class included only about one third as many black and Indian members as there had been in the freshmen class four years earlier, and only about 45 percent as many Hispanic graduates. By this same measure of attrition, each graduating class included about 70 percent as many students as the freshman class of four years earlier (fig. 9).

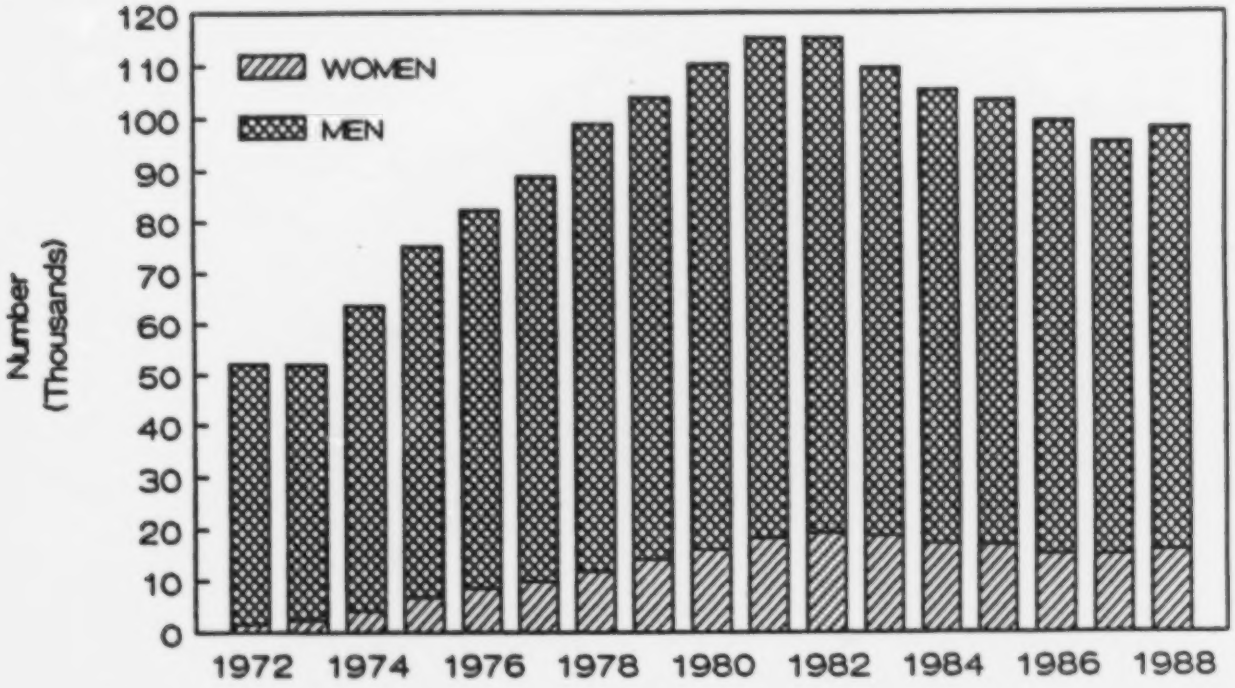


Figure 7. Freshman Enrollment in Engineering, 1972-88, by Sex. Data Source: Engineering Manpower Commission

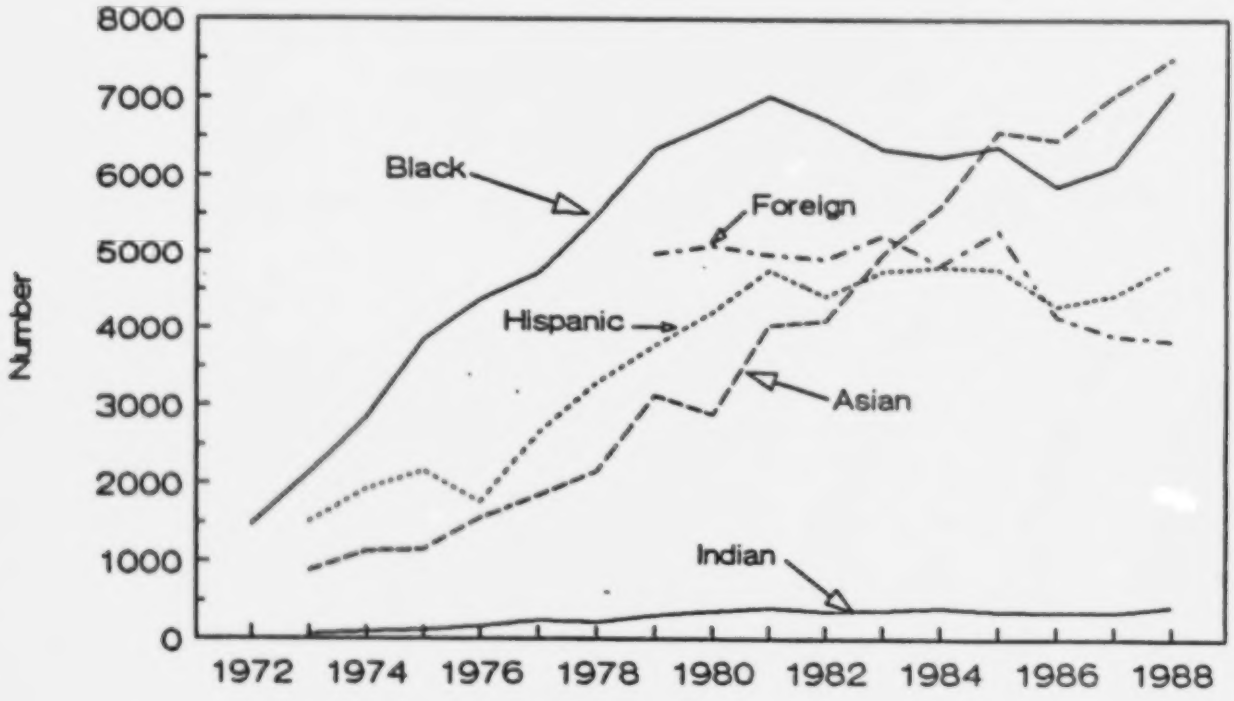


Figure 8. Minority Engineering Freshmen, 1972-1988, by Minority. Data Source: Engineering Manpower Commission

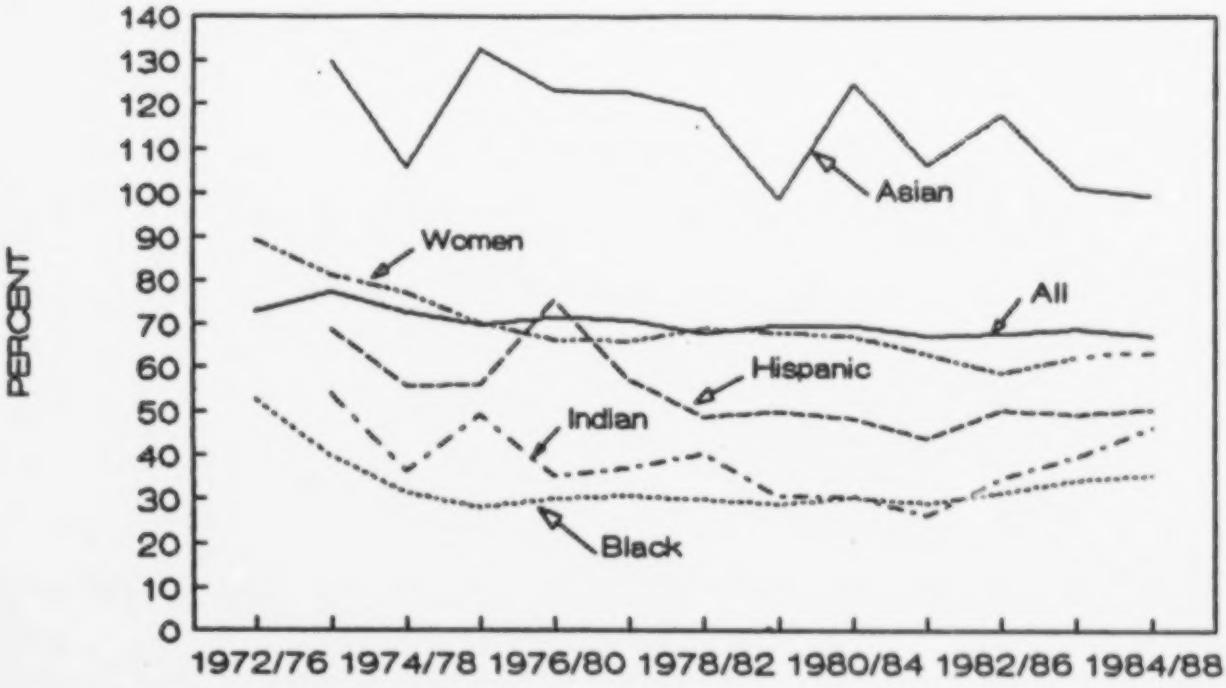


Figure 9. Retention Rates of Freshman Engineers, 1972/76 - 1984/88, by Minority Group. Data Source: Engineering Manpower Commission

Among the Asian minority, however, there were more graduates than the number of freshmen four years earlier! This neat feat resulted from the fact that the freshman enrollment survey counts only those students enrolled in engineering schools with four year programs. Other students who are taking the first two years of their engineering program at a two year college and will transfer to the four year school at the junior year are not counted among the freshmen. Thus, because fewer Asian students left engineering at the freshman and sophomore levels than transferred in at the junior year from the two year programs, the retention rate for Asian students averaged 110 percent! This also emphasizes, however, that the attrition rate among black, Hispanic and Indian students is even higher than is shown by the freshman and B.S. comparison.

Because of the high attrition rate, the number of minority graduates in engineering has continued to be very small (fig. 10). As a proportion of the engineering B.S. graduating class, black, Hispanic and American Indian students combined make up only seven percent of the 1988 engineering bachelor's graduates (fig. 11). The good news is that this apparent attrition rate is less in 1987 and 1988 than in previous years.

Only 48,500 non-Asian minority engineers have earned engineering bachelor's degrees from American universities since 1973, and this 15 year total includes approximately 400 Hispanic students per year who are graduates of the University of Puerto Rico. Thus far, the proportion of minority engineers in the American workforce is not increasing nearly as fast as the proportion of minority individuals in the American population, although some improvement is evident in the last two years.

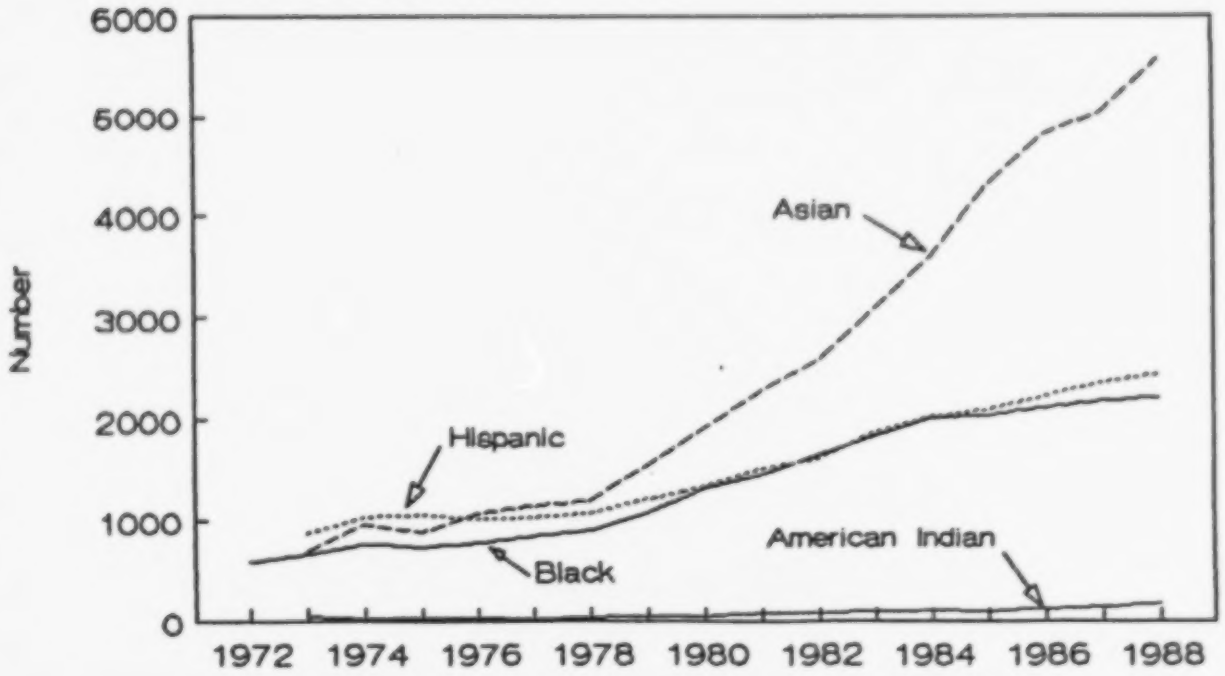


Figure 10. Minority B.S. Graduates in Engineering, 1972-1988. Data Source: Engineering Manpower Commission

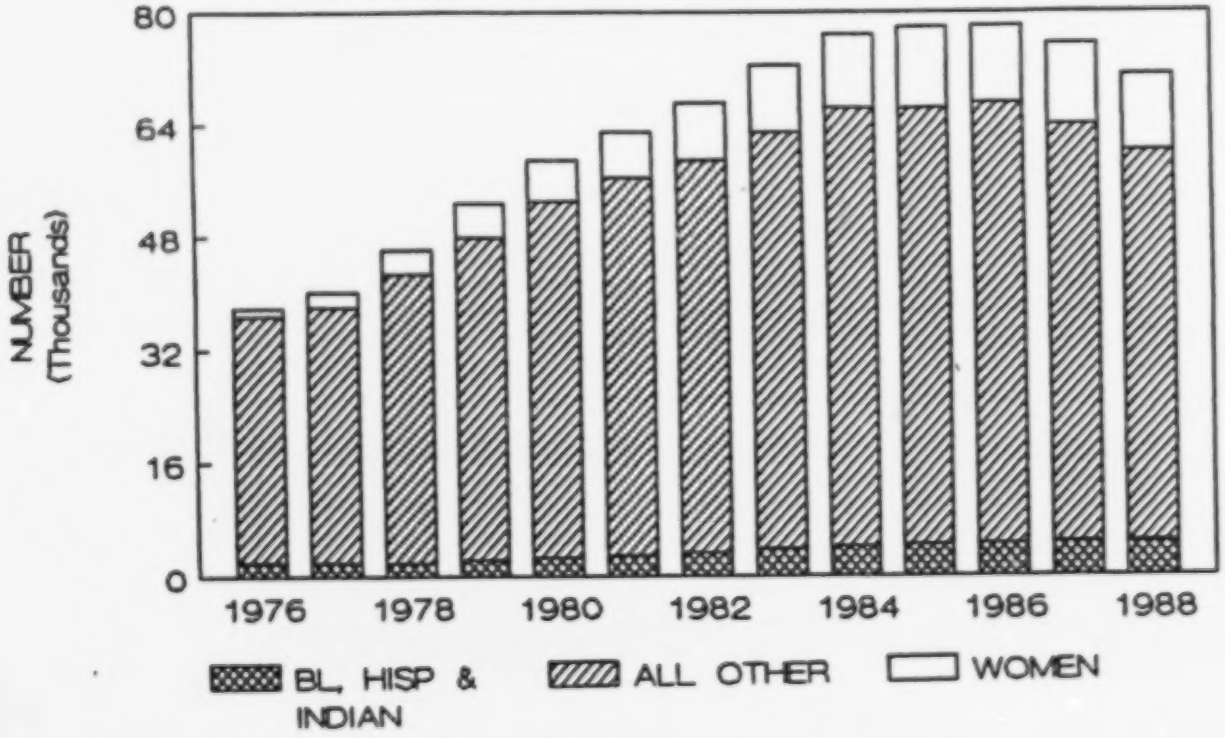


Figure 11. Engineering Bachelor's Degrees, 1976-88. Data Source: Engineering Manpower Commission

As is true in most data bases providing breakouts for women and minorities, minority and foreign women are double counted in the enrollment and degree data from the Engineering Manpower Commission. New data from the graduating class of 1987, as provided through the National Center for Education Statistics, shows that women are somewhat better represented among minority engineering graduates than among white, non-Hispanic ones (fig. 12). Among blacks, women are 30 percent of engineering baccalaureate recipients, although the proportions drop off rapidly at higher degree levels. Women are least common among foreign graduates, who make up only eight percent of the baccalaureate graduates from American engineering schools, but who earn more than half of the doctoral engineering degrees awarded by American universities.

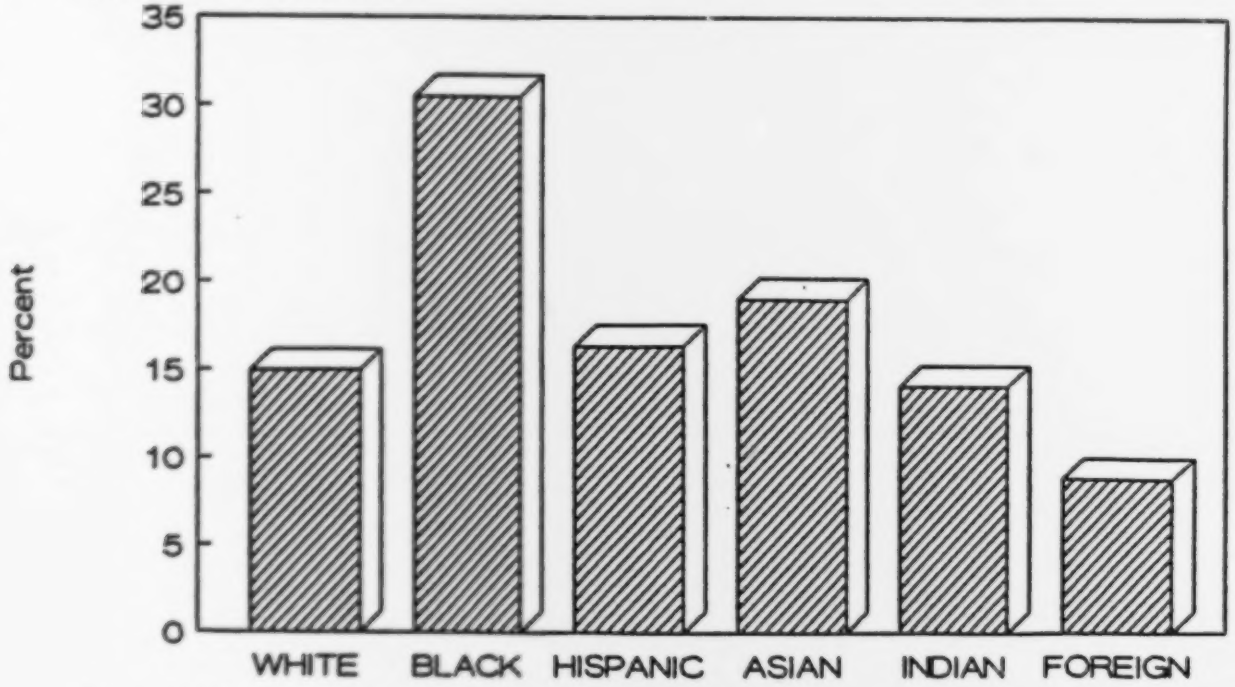


Figure 12. Percent Women Within Each Racial/Ethnic Group of Engineering BS Graduates in 1987. Data Source: National Center for Education Statistics

Science Bachelor's Graduates

The minority record in the sciences is somewhat better than in engineering, although non-Asian minority graduates are more likely to major in one of the social sciences than in any of the natural sciences. As a proportion of all bachelor's graduates in the natural science fields (fig. 13), blacks earned a remarkable 7.4 percent of the computer and information science degrees, due specifically to the 1,599 black women among the recipients, who earned 53 percent of the 2,998 bachelor's degrees awarded to blacks in this field in 1987. Both Hispanics and Native Americans were somewhat more likely to earn degrees in the life sciences than in other science fields.

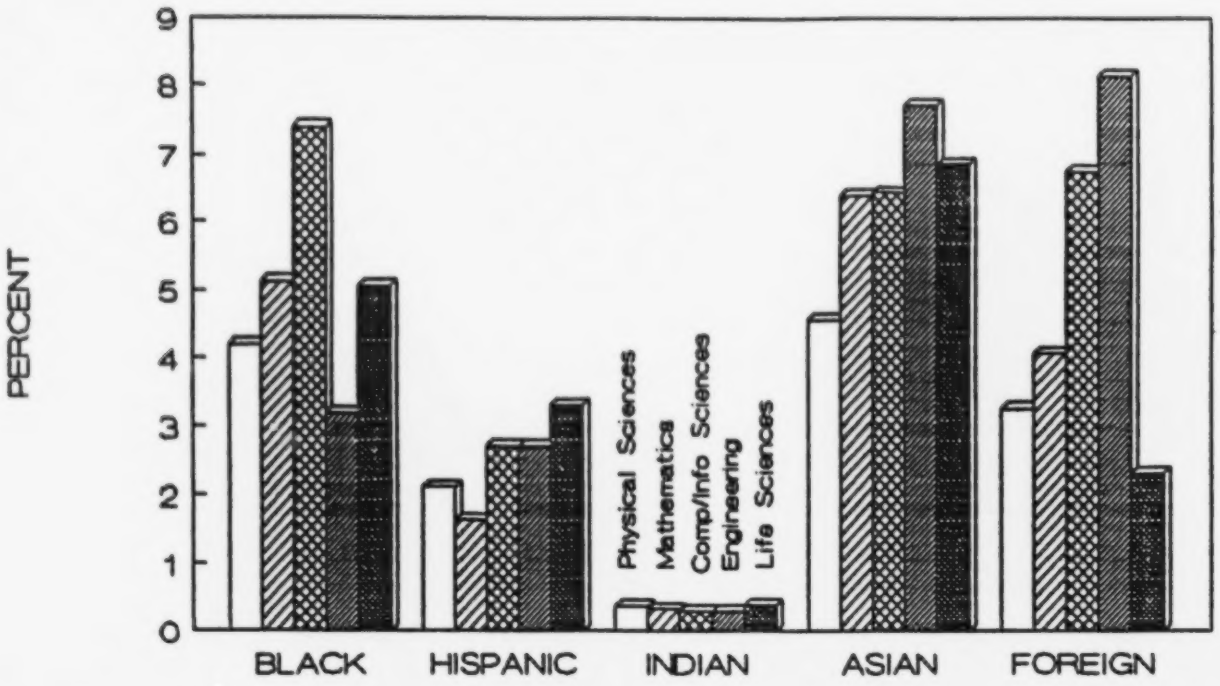


Figure 13. Percent of Natural Science and Engineering Bachelor's Degrees Awarded to Minorities in 1987, by Minority Group. Data Source: National Center for Education Statistics

In all of science and engineering, including the social and behavioral sciences, blacks earned 5.2 percent of the bachelor's degree awards in 1987, Hispanics 2.7 percent, American Indians 0.4 percent, Asians 5.0 percent and foreign students, 4.1 percent. In 1985, the comparable percentages were 4.9 percent for blacks, 2.6 percent for Hispanics, 0.3 percent for American Indians and 4.0 percent for foreign students.

Women earned more than half (51.2 percent) of all bachelor's degrees awarded in 1987, and American minority women earned eleven percent of the degrees earned by women. In science and engineering, the proportion of women among degree recipients drops to 31.4 percent, and in the natural science and engineering fields, women earned only 23.9 percent of baccalaureate awards. Minority women follow the same pattern (fig. 14).

The number of women earning bachelor's degrees in science and engineering dropped in 1987 in all of the natural science fields, although a slight increase occurred in both the social and behavioral sciences (fig. 15). This was expected because of the drop in the number of age 22 Americans. However, the number of minority women earning bachelor's degrees is up from 1965 both in total degree awards and in the number awarded in science and engineering fields. Minority women earned 17.4 percent of natural science and engineering degrees earned by women in 1987, up from 14.4 percent in 1985. This includes 7 percent that were earned by Asian women in 1987, and 5.5 percent in 1985.

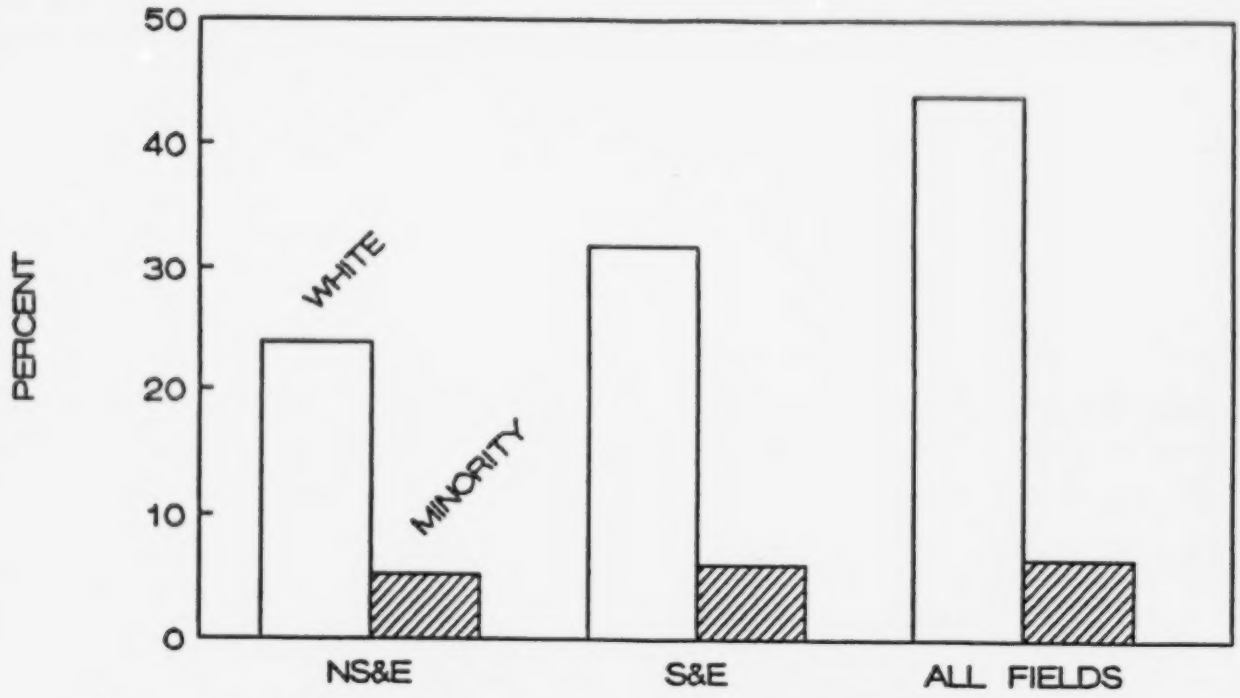


Figure 14. Percent of Bachelor's Degrees Earned by White and Minority Women in Natural Science and Engineering, All Science and Engineering, and all Fields, 1987. Data Source: NCES

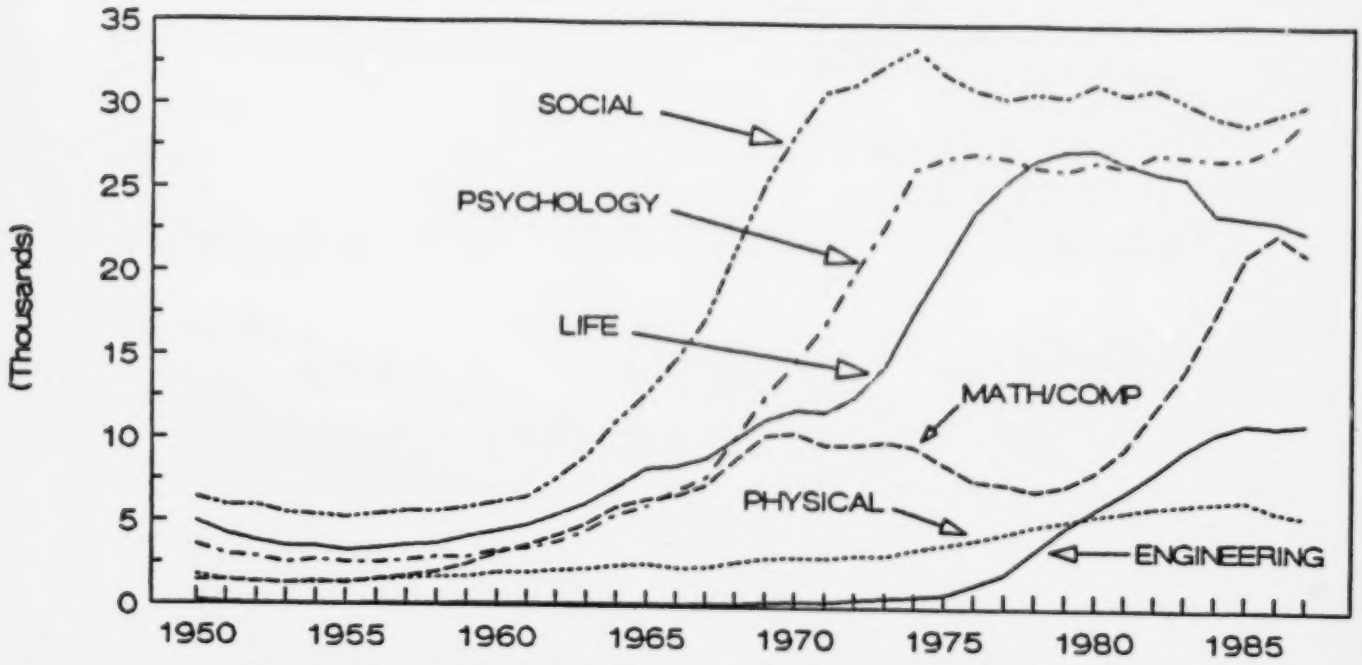


Figure 15. Women Bachelor's Graduates in Science and Engineering 1950-87. Data Source: National Center for Education Statistics

Minority men as well as women show substantial increases in degree awards in natural science and engineering fields. The increase in minority representation among these graduates rose from 11.4 percent of the total in 1985 to 13.9 percent in 1987. Asians make up almost half of the minority degree recipients in these fields. The change from 1985 is even sharper, having risen from 11.4 percent to 13.9 percent. However, Asian students constitute 46.4 percent of all these minority graduates, and the representation of blacks, Hispanics and American Indians among degree recipients remains at only half of their representation in the population.

Graduate School

Except for students of Asian background, minority students are even less represented in graduate school than among baccalaureate graduates (fig. 16). Reasons probably include lack of financial resources, need to repay debts from the undergraduate years, or support requirements for family members.

There is substantial evidence that neither women nor minority men are as likely to be supported by fellowships, scholarships or research assistantships as are American men, or even foreign students. In part, levels and type of support are determined by the fields of study chosen. For example, only seven percent of full time graduate students in the physical sciences in fall 1987 reported self-support as their principal source of support, but 46 percent of students in the social sciences said they were dependent principally on self support, according to the National Science Foundation.

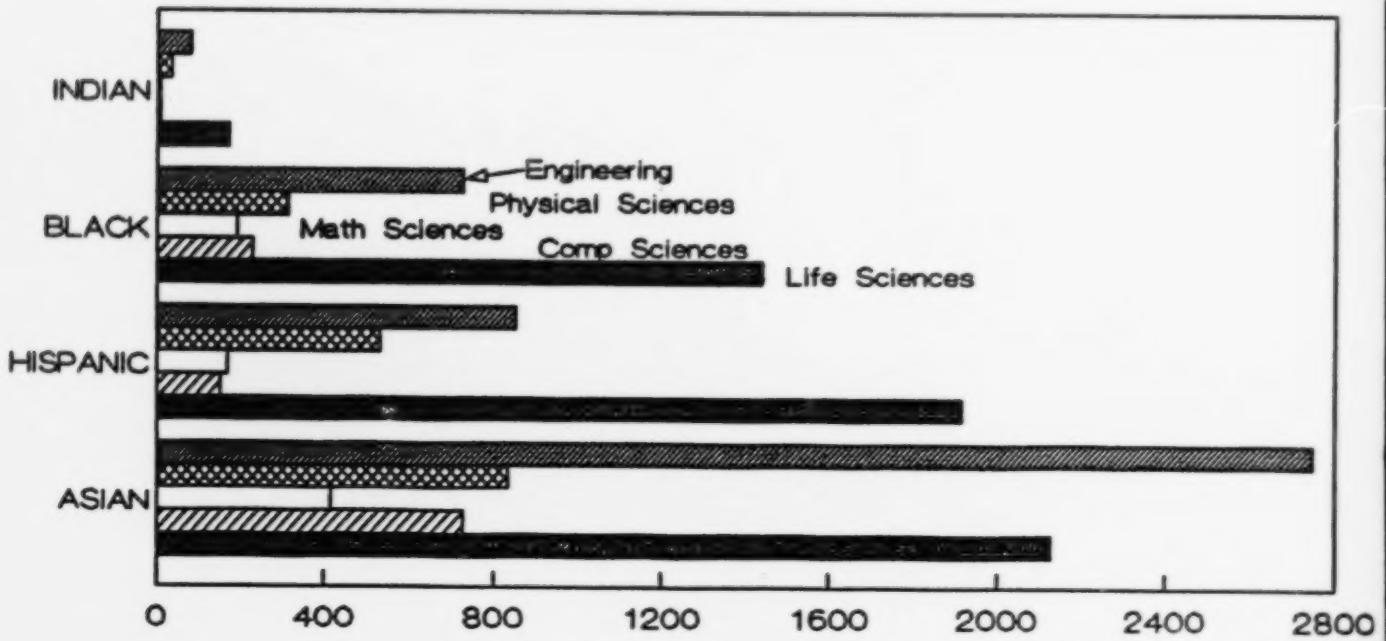


Figure 16. Minority Graduate Students in Natural Science and Engineering, 1986-87. Data Source: National Science Foundation

As has been demonstrated, women and non-Asian minorities are more likely to major in fields with less available outside support than in those where more support is available, including particularly the physical sciences.

Master's Degrees

Master's degrees are important milestones for individuals, but their meaning is varied. Some schools give master's degrees to students who are not accepted into a doctoral program. Others provide a master's degree as an award on the way to a Ph.D. In other cases, the master's degree is the highest degree sought by an individual.

The number of academic credits required for a master's degree also varies by individual school, and sometimes by field. Some master's degrees can be earned in one academic year; others require at least two. So although it is not altogether clear what this degree represents, it indicates at a minimum successful completion of a prescribed course of study beyond the bachelor's degree. It is also another level at which to measure the participation of minorities. Once again, except for Asian students in engineering, the mathematical and physical sciences, the proportion of minority recipients among master's graduates is below their representation at the bachelor's level.

The percentage of master's degrees in natural science and engineering fields that are earned by minorities is shown in figure 17. The drop for blacks, Hispanics and Indians from the bachelor's level is plain.

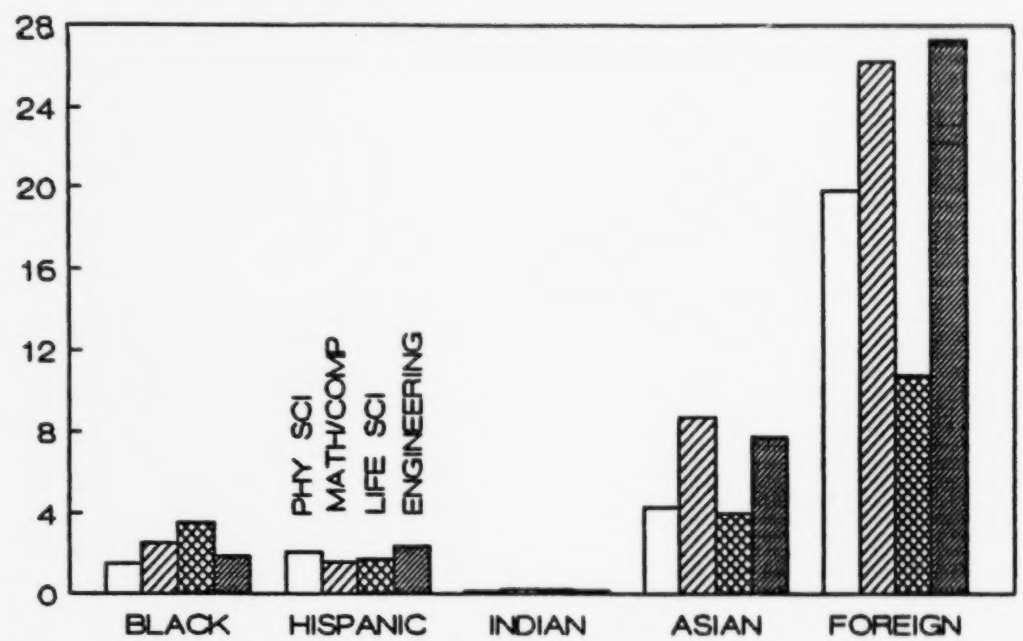


Figure 17. Percent of Natural Science and Engineering Master's Degrees Awarded to Minorities in 1987. Data Source: NCES

Asian students earn a higher proportion of the master's degrees in these fields than was true at the bachelor's level, while the representation of foreign students among master's graduates is quadruple their representation at the bachelor's level. There is a sharp contrast between the American minority groups and foreign students in the proportion of degrees earned at each higher degree level, with the abrupt increase in foreign students at the master's level particularly notable in the natural science and engineering fields (fig. 18).

Women earn slightly more than half of all bachelor's and master's degrees in all fields combined, but the proportions drop off substantially in the natural science and engineering fields. Adding the social and behavioral sciences brings the representation of women to about 40 percent at the bachelor's level, but women earn only a third of the master's degrees in these fields, and drop still further among the PhDs. Of course, even for all fields combined, women earn only 35 percent of the doctoral awards (fig. 19).

Minority women are far less well represented among the advanced degree graduates than at the bachelor's level. In 1987, black, Hispanic and Indian women combined earned only 87 doctorates in the natural sciences and engineering - or 3.6 percent of those awarded to women. Asian women earned 5.8 percent, foreign women 17.9 percent and white women 72.7 percent of the doctorates in these fields that were earned by women. As a group, women earned only 18.9 percent of doctorates awarded in the natural science and engineering fields.

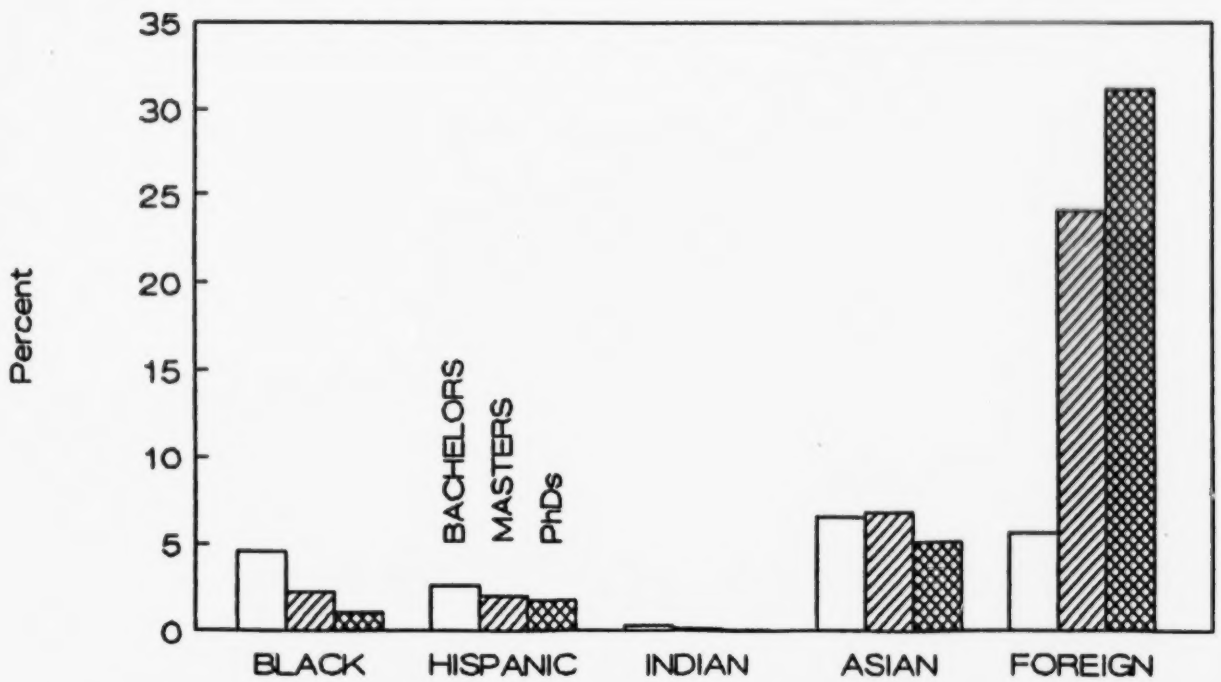


Figure 18. Percent of Natural Science and Engineering Degrees Earned by Minorities in 1987, by Minority and Degree Level. Data Source: NCES

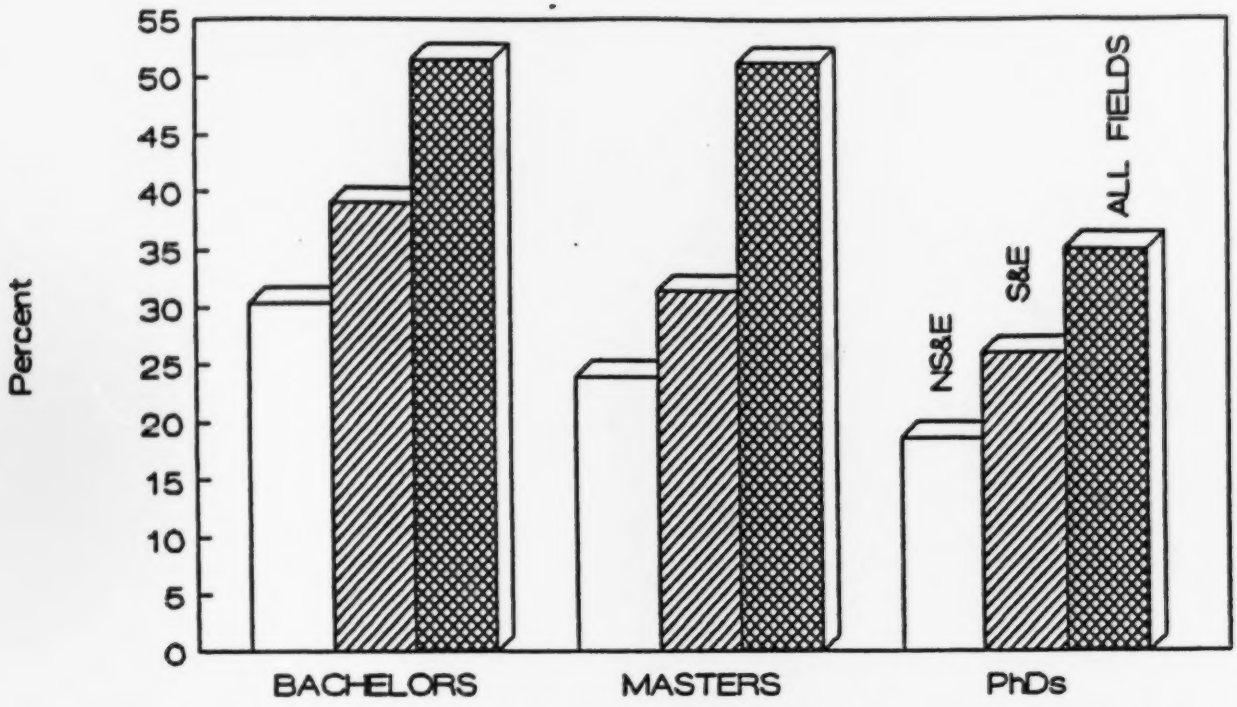


Figure 19. Percent Women Among Graduates in Natural Science and Engineering, All Science and Engineering, and All Fields, by Degree Level, 1987. Data Source: National Center for Education Statistics.

AMERICAN DOCTORATES

It is at the doctoral level that the largest proportional drop occurs, particularly in science and engineering, among both women and non-Asian minorities. The number of foreign graduates increases substantially over the master's level, so that the proportion of foreign PhD graduates in engineering exceeds 50 percent, and is nearly half in some of the physical sciences.

Looking only at the American citizens among the PhD graduates, it is apparent that relatively little progress has been made in the natural science and engineering fields among American minorities over the past decade. Blacks and Hispanics earn less than two percent each of the doctorates awarded to American citizens; Native Americans earn less than half of one percent; and Asian Americans earn less than five percent of these degrees (fig. 20). The numbers of doctorates in these fields that are awarded to minorities of either sex are miniscule - fewer than 200 each for blacks and Hispanics, and only 33 for Native Americans in 1988.

Minority women earn so few doctorates in the natural science and engineering fields that even the largest group, the Asian American women, earn fewer than 100 PhDs nation-wide each year (fig. 21).

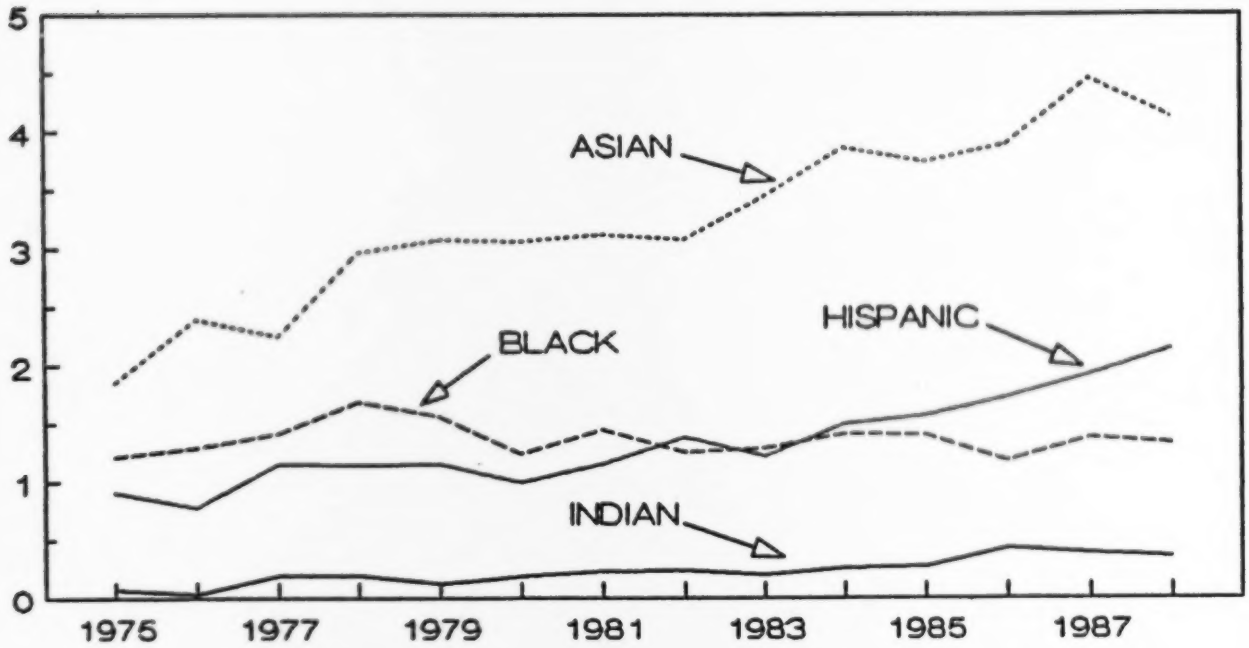


Figure 20. Percent of Minority Recipients Among Natural Science and Engineering PhDs Who Are American Citizens, 1975-1988, by Minority Group. Data Source: National Research Council

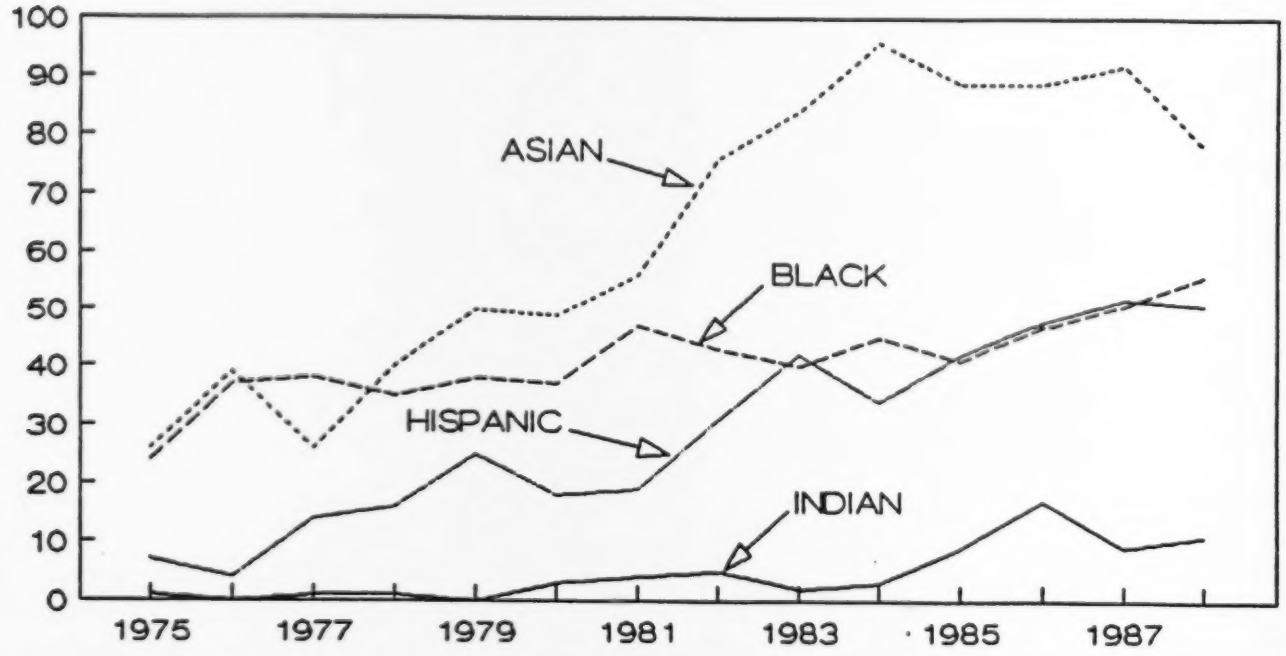


Figure 21. Number of Minority Women Doctorates in Natural Science and Engineering, 1975-1988, by Minority Group. Data Source: National Research Council

When doctoral awards to American minorities are broken out by broad field of science and sex, it is apparent that there are far too few graduates to fill the needs for role models in any employment settings. In engineering (fig. 22), non-minority women display the largest under-representation, relative to their proportion in the American population, but very few doctorates are awarded to any minority recipients of either sex. In the physical sciences (fig. 23) and the life sciences (fig. 24), the number of degree awards to either men or women in any minority group stay below 100 doctorates per year, even when Indian, Black and Hispanic recipients are combined by sex.

It is commonly believed that American or immigrant students of Asian ancestry need no assistance in earning degrees in science and engineering fields. Indeed, such students are believed to be "over-represented" relative to their proportion in the population. What is not widely recognized, however, is that most Asian recipients of doctoral degrees in these fields are foreign citizens, and that among Asian Americans, the proportion of degree recipients is no higher than their proportion of the population (fig. 25). Even among the working doctoral population of the United States in 1987, most of the Asian scientists and engineers (85 percent) were foreign born. Thus, although Asians made up 8.7 percent of employed doctoral scientists and engineers in 1987, they also constituted the majority of the 6.1 percent of employed doctoral scientists and engineers who were not American citizens. Even many of the citizens of Asian ancestry were foreign born.

Regardless of racial or ethnic group, women earn fewer science and engineering doctorates than men (fig. 26). However, because the number of black men earning PhDs in these fields has been dropping since 1977, black women earned more doctorates than men in 1986 and 1987. In 1988, the number earned by men rose to slightly exceded the number awarded to women.

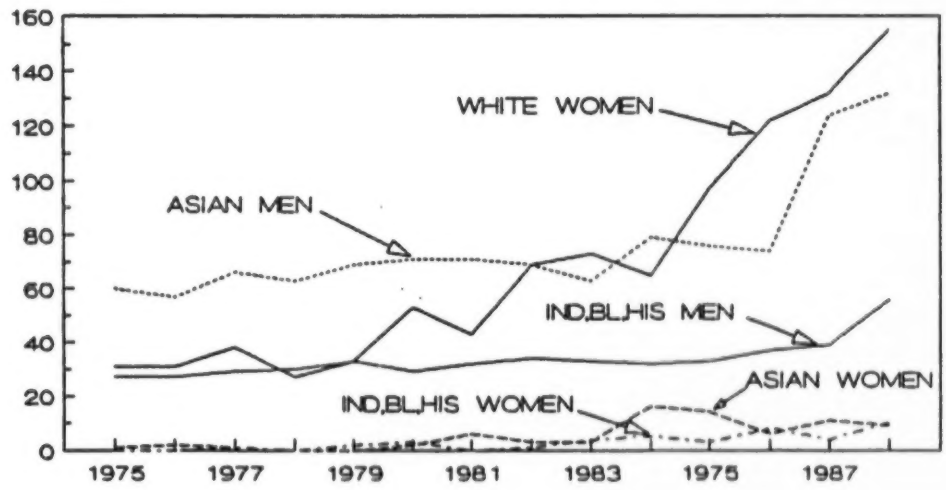


Figure 22. American Minority PhDs in Engineering, 1975-1988. Data Source: National Research Council

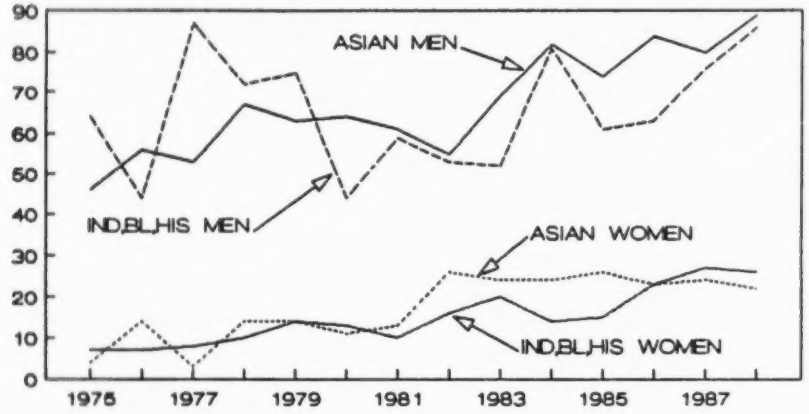


Figure 23. American Minority PhDs in Physical Sciences, 1975-1988. Data Source: National Research Council

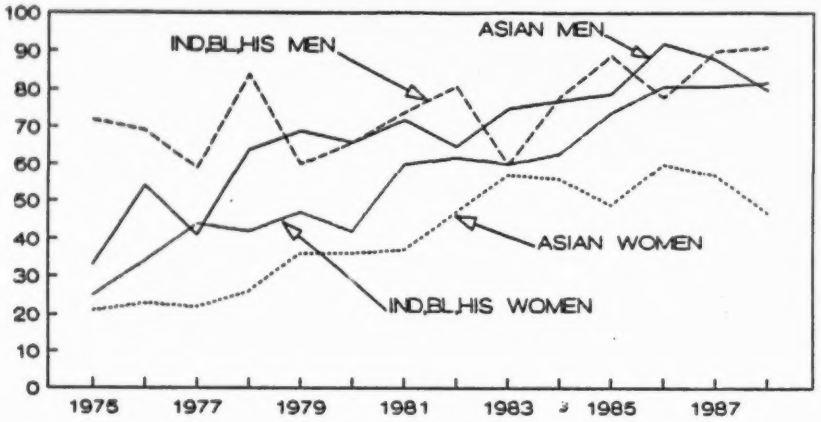


Figure 24. American Minority PhDs in Life Sciences, 1975-88. Data Source: National Research Council

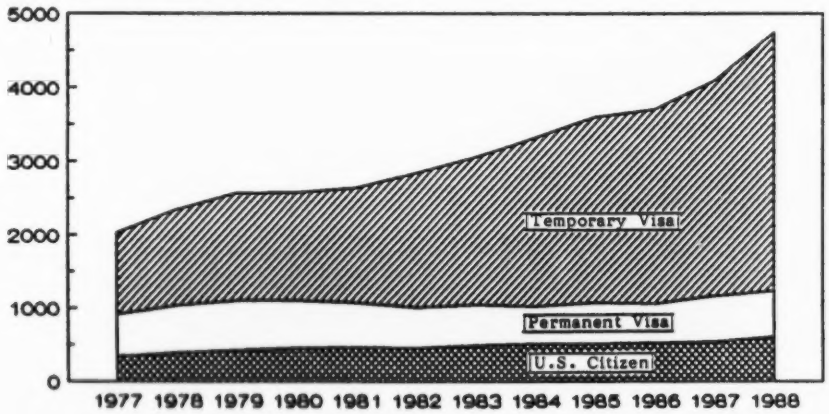
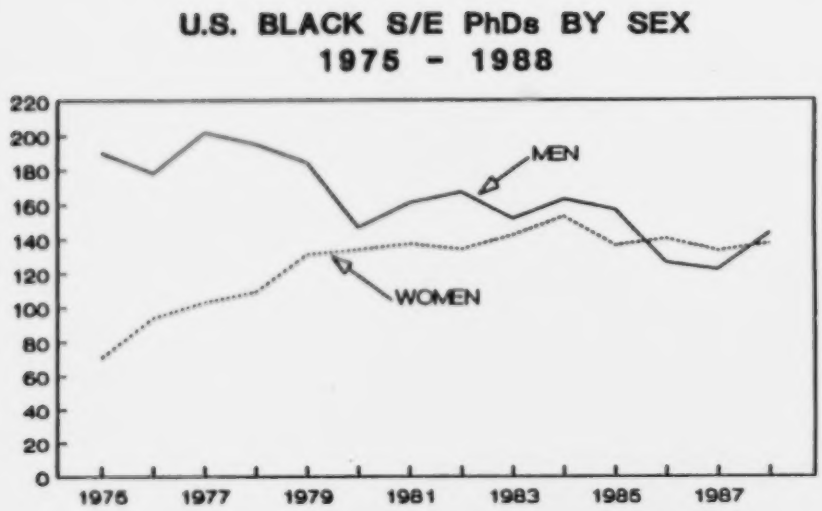
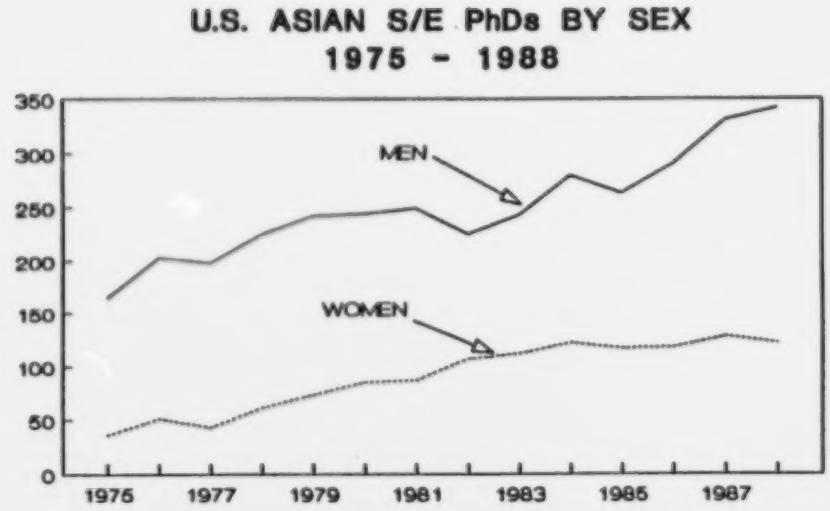
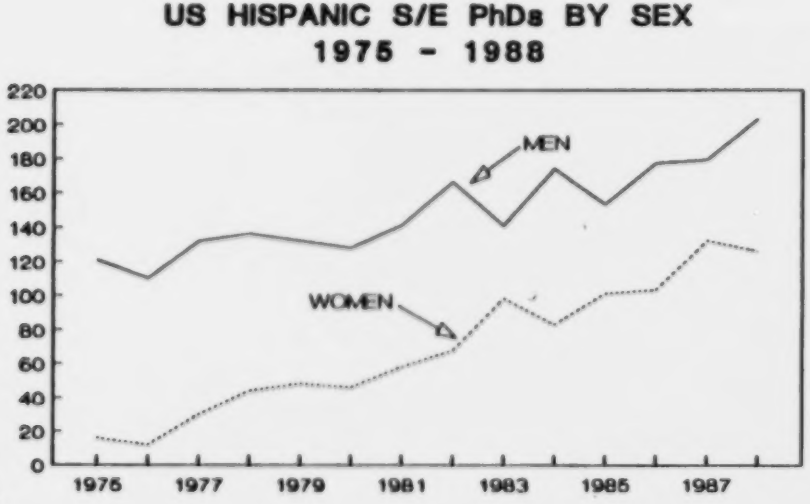


Figure 25. Citizenship and Visa Status of Asian Doctoral Recipients from American Universities, 1977-1988. Data Source: National Research Council







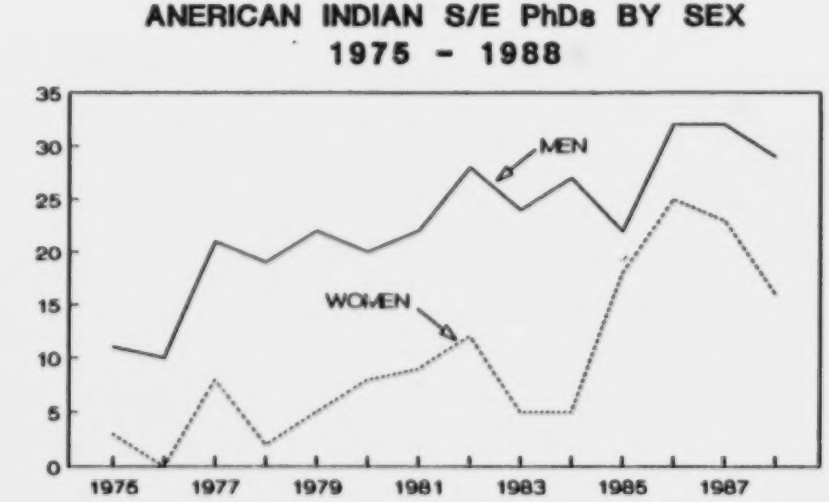


Figure 26. Number of American Minority Doctoral Recipients in Science and Engineering, by Sex and Race or Ethnicity, 1975-1988. Data Source: National Research Council

FACULTY

One of the most important needs for minority doctorates in science and engineering is for faculty members in these fields, both because of projected shortages in faculty that will begin to occur by the mid-nineties, and because minority students have almost no role models in the academic workforce. This is particularly true in science and engineering fields. The percentage of black faculty almost doubled in the social and behavioral sciences from 1975 to 1985, but even that doubling raised their presence only to 2.8 percent of the total. (fig. 27). In engineering, blacks are less than one percent of the faculty, although foreign citizens constituted more than ten percent in the same year. Black faculty in the mathematical and physical sciences had not yet reached one percent by 1985, and their representation in the life sciences was little better.

Women students in these fields, whether minority or majority women, will find few female role models among the faculty in engineering, mathematics or the physical sciences (fig. 28). Although the proportion of women on life science faculties increased considerably between 1975 and 1985, the presence of women faculty members is still far below their representation in the student body, as well as among doctoral recipients in these fields. In the life, social and behavioral sciences, about one in five faculty members is a woman, but the student body in these fields is nearer fifty percent at the undergraduate level. The number of women faculty in the mathematical and physical sciences remains ridiculously small, and in engineering, there are only a tenth as many women faculty as there are foreign faculty! Women students in engineering have no place to turn for help with problems that arise from the sex or cultural background of their faculty.

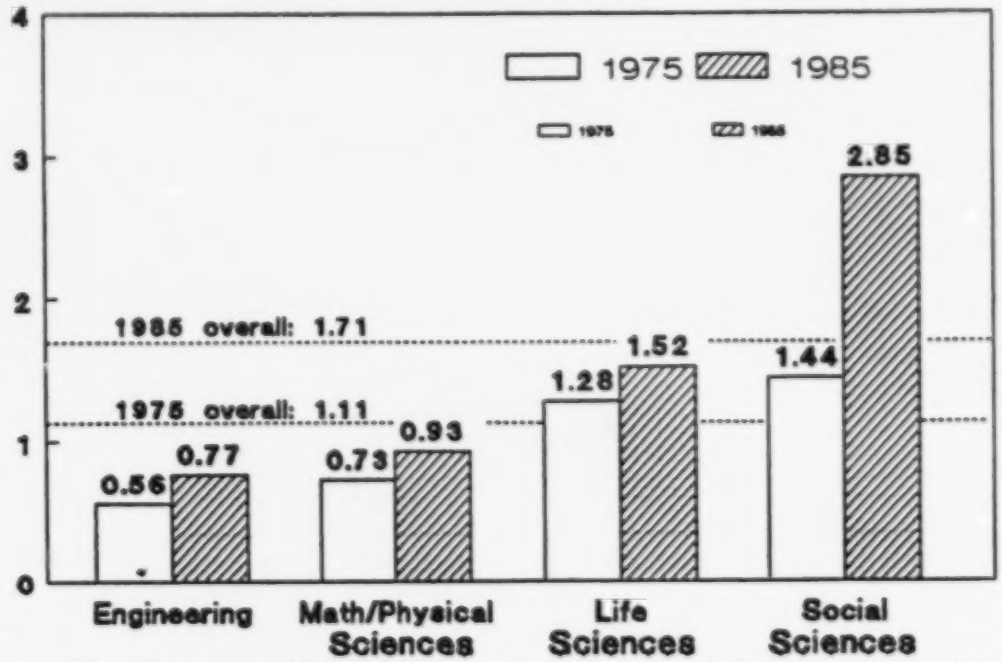


Figure 27. Percent of Black Faculty in Science and Engineering, 1975 and 1985, by Broad Field. Data Source: National Science Foundation

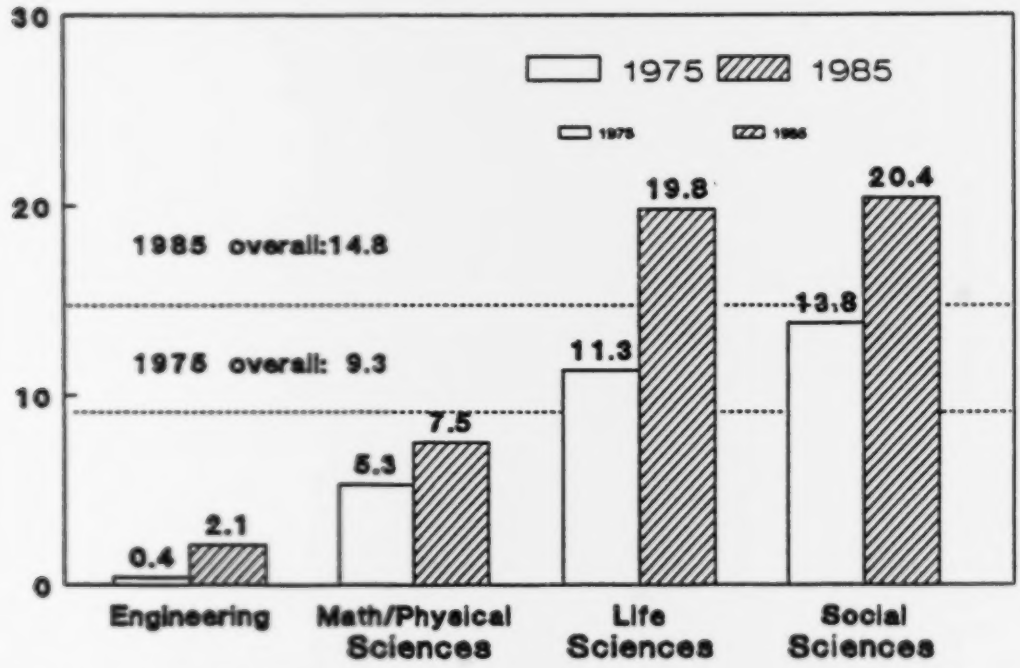


Figure 28. Percent of Women Faculty in Science and Engineering, 1975 and 1985, by Broad Field. Data Source: National Science Foundation

FORECASTS

Although the ability to forecast the future is always limited, the National Science Foundation has prepared a projection of the doctoral positions that are expected to be available for natural scientists and engineers through 2004 (fig. 29). The projected academic demand reflects both the changes that are and will be occurring in the size of the college age population (fig. 6) and the aging of current science and engineering faculty (fig. 30).

Even by 1985, 32 percent of that faculty was age 50 or over, and by 1987, 46 percent of all doctoral scientists and engineers employed by four year colleges and universities were in that age group! Of employed doctoral scientists and engineers who list teaching as their principal activity, 40 percent are in this age group. Thus, it is apparent that as the size of the college age population starts up again by the turn of the century, faculty retirements will be opening a great many positions in academe. Meantime, the need for doctoral researchers in industry and government laboratories is expected to continue at least at the present levels.

In 1988, when the size of the age 30 population was at its peak (fig. 6), American Universities awarded doctorates in natural science and engineering to 7,455 American citizens, including 523 (7.2 percent) awarded to minorities. The National Science Foundation projection indicates positions for about 18,000 new PhDs in natural science and engineering in 2004, when the size of the age 30 population reaches bottom. Where are they to come from?

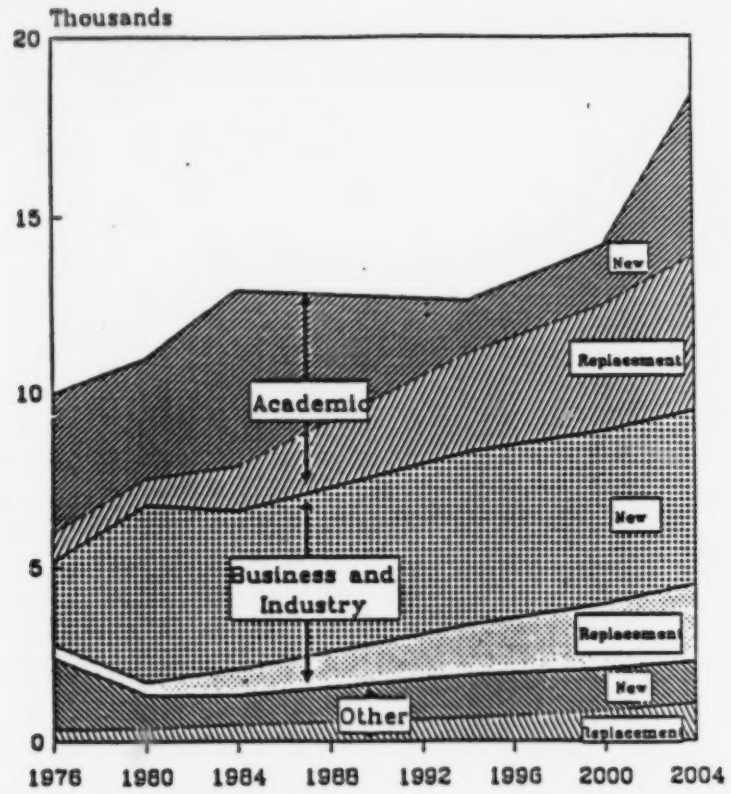


Figure 29. Available PhD Positions for Natural Scientists and Engineers, by Type of Employer, 1976-2004.

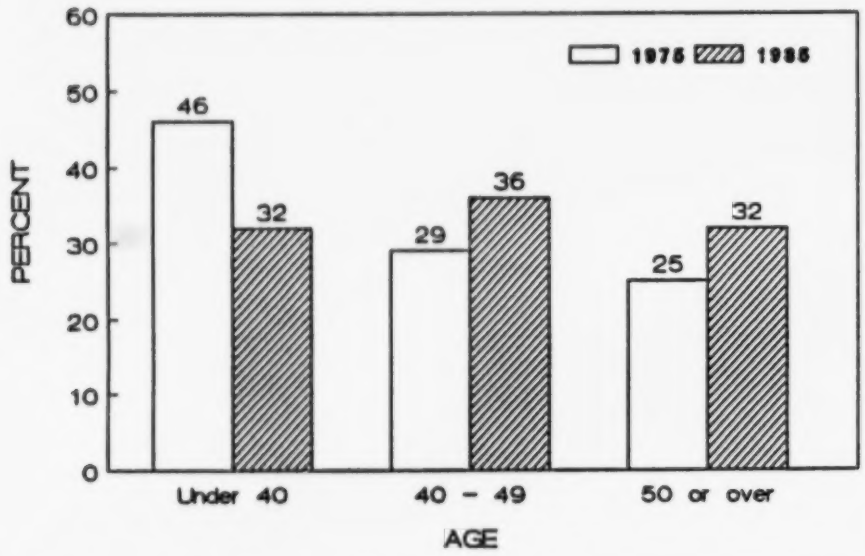


Figure 30. Age of Academic PhD Scientists and Engineers, 1975 and 1985. Data Source: National Science Foundation

Some of the apparent deficit can be made up by retaining for the American work force some proportion of the foreign citizens who graduate each year from our universities, and who wish to remain here. But the nation cannot expect to meet its needs for these specialists by retaining more and more of our foreign graduates. If we are to continue to compete with the rest of the world in technological areas, more of our own young people must be recruited.

Half of our children are girls. A growing third are members of minority groups, and one sixth are in the double bind of being both female and minority. Put another way, only one third are white, non-hispanic boys. The world's leading democracy cannot afford to depend on only one third of its population for leadership in science and medicine, in law and politics, and in all other fields, nor can it afford to have large segments of its youth ignorant of both the facts and processes of science.

Not only do we have fewer children than we had during the past two decades, but fewer and fewer of them are adequately prepared to select college programs in science or engineering by the time they leave high school. The proportion of the eligible of all racial and ethnic groups and both sexes, who are choosing to major in these fields is shrinking steadily (fig. 31).

Our need for scientists and engineers will continue to grow if we try to remain technologically competitive with nations whose children know far more than ours about mathematics and science. We cannot waste another day before acting to improve the science literacy of our children, including particularly that growing 65 percent who are not white and male.

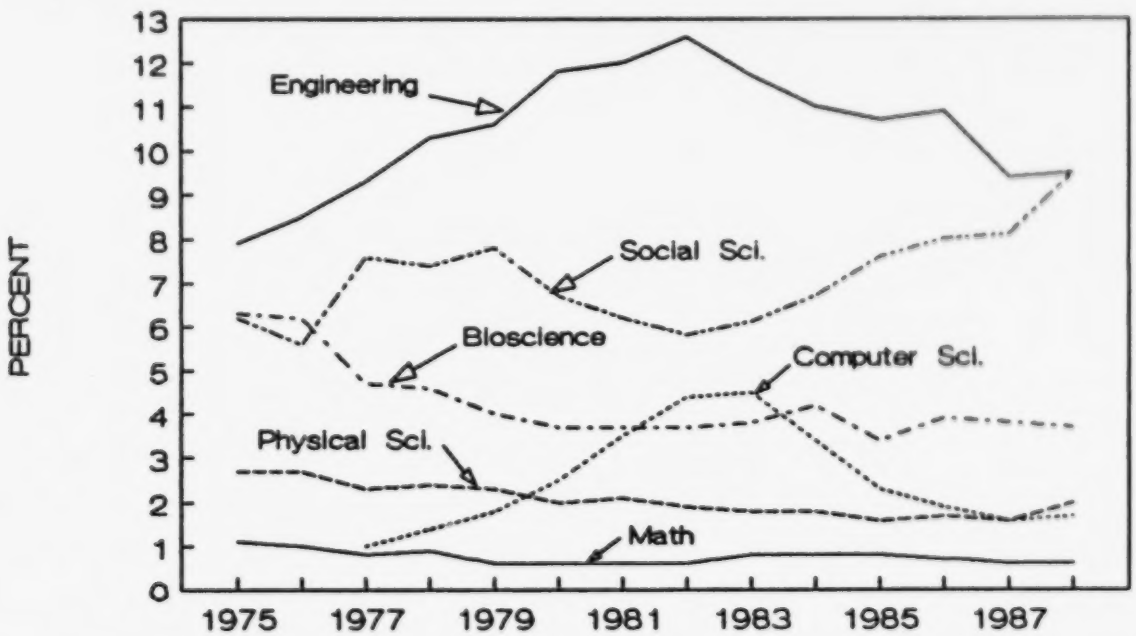


Figure 31. Freshman Plans for Majors in Science and Engineering 1975-1988.
Data Source: Cooperative Institutional Research Program

DATA SOURCES

Cooperative Institutional Research Program of the American Council on Education and the University of California at Los Angeles Graduate School of Education

Astin, Alexander, et al. Annual Series on **The American Freshman, National Norms for Fall 1975** through **1988**

Commission on Professionals in Science and Technology (CPST)

Hodgkinson, Harold. "Demographic Imperatives for Science," in **Competition for Human Resources in Science and Engineering in the 1990s**, Proceedings of a Symposium, May 1988.

Vetter, Betty M. and Eleanor L. Babco, (Eds). **Professional Women and Minorities: A Manpower Data Resource Service**, Seventh Edition, December 1987 and Eighth Edition, in preparation.

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Engineering and Technology Enrollments Fall 1970 through **Fall 1988.**

Engineering and Technology Degrees 1970 through **1988.**

National Center for Education Statistics (NCES) of the U.S. Department of Education

Degrees and Other Formal Awards Conferred, 1986-87 Survey, Unpublished.

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National Science Foundation

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Foreign Citizens in U.S. Science and Engineering: History, Status and Outlook, 1987.

"Personnel in Natural Science and Engineering," unpublished working draft, June 1988.

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